

Sciurus nayaritensis. By Troy L. Best

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Sciurus nayaritensis Allen, 1889

Mexican Fox Squirrel

Sciurus alstoni Allen, 1889:167. Type locality "Sierra de Valparaíso, Zacatecas," Mexico. Not *Sciurus alstoni* Anderson (= *Callosciurus alstoni*).

[*Sciurus*] *nayaritensis* Allen, 1890:vii, renaming of *Sciurus alstoni*. *Sciurus apache* Allen, 1893:29. Type locality "Northern Chihuahua." Restricted to "western slope of the Sierra de Nacori in eastern Sonora [Mexico], at an altitude of 6300 feet" (van Rossem, 1936:417).

Sciurus chiricahuae Goldman, 1933:71. Type locality "Cave Creek, Chiricahua Mountains, Cochise County, Arizona (altitude 5,200 feet)."

CONTEXT AND CONTENT. Order Rodentia, Suborder Sciurognathi, Family Sciuridae, Subfamily Sciurinae, Genus *Sciurus*, Subgenus *Sciurus* (Wilson and Reeder, 1993). Based upon structure of the hyoid bones, *S. nayaritensis* also has been placed into the subgenus *Parasciurus* (Hoffmeister and Hoffmeister, 1991). The genus *Sciurus* contains 28 species (Wilson and Reeder, 1993). Three subspecies of *S. nayaritensis* are recognized (Hall, 1981; Lee and Hoffmeister, 1963):

S. n. apache Allen, 1893:29, see above.

S. n. chiricahuae Goldman, 1933:71, see above.

S. n. nayaritensis Allen, 1890:vii, see above (*alstoni* Allen is a synonym).

DIAGNOSIS. *Sciurus nayaritensis* may be sympatric with *S. aberti*, *S. aureogaster*, and *S. colliaei* (Anderson, 1972; Baker and Greer, 1962; Caire, 1978; Hall, 1981; Hoffmeister, 1986; Matson and Baker, 1986; Musser, 1968; Nelson, 1899). Compared with *S. aberti*, *S. nayaritensis* never has ear tufts, there is one upper premolar rather than two, the rostrum is broader, and the braincase of *S. nayaritensis* is more inflated than in *S. aberti* (Hoffmeister, 1986). Compared with *S. aureogaster*, *S. nayaritensis* has one upper premolar rather than two; their ranges may overlap in Colima, Jalisco, Nayarit, and Zacatecas (Hall, 1981; Matson and Baker, 1986). Compared with *S. colliaei*, which has a whitish to grayish venter, the venter of *S. nayaritensis* has an orange hue (Caire, 1978), and *S. nayaritensis* has one upper premolar rather than two (Hall, 1981). In Sonora, *S. nayaritensis* is larger, its fine-textured pelage is denser and longer than in *S. colliaei*, and the skull of *S. nayaritensis* is >63 mm in length and the zygomatic breadth is >36 mm (Caire, 1978).

The ranges of *S. nayaritensis* and *S. arizonensis* approach each other in Arizona and Sonora (Hall, 1981). The skull of *S. nayaritensis* is nearly indistinguishable from that of *S. arizonensis*, and external and most cranial measurements of the two species are almost identical. Thus, these taxa may be conspecific, but there is a marked difference in color, and certain cranial features are useful in distinguishing them. Compared with *S. arizonensis*, the underparts of *S. nayaritensis* are orangeish rather than whitish, the sides of the body are conspicuously reddish or ochraceous, the legs and feet are reddish or ochraceous rather than brownish interspersed with white and tan, the upperparts are reddish rather than mostly gray with some brownish, and the tail is bordered with tan or yellow rather than white. Although color varies considerably throughout the range of *S. nayaritensis*, the variation is not as great as that between *S. arizonensis* and *S. nayaritensis* in Arizona. Compared with *S. arizonensis*, the skull of *S. nayaritensis* is broader across the base of the rostrum, as indicated by width across the premaxillary-maxillary sutures (usually ≥ 14.8 mm rather than ≤ 14.7 mm), and width across the infraorbital canals (usually ≥ 13.4 mm rather than less). Inflation of the braincase in the interorbital part of the skull

is greater in *S. nayaritensis*, usually ≥ 21.3 mm rather than less, as measured from the crown of the upper molars to the top of the skull in the interorbital region. The toothrow is slightly longer in *S. nayaritensis*, and the breadth across the zygomatic arches is slightly greater than in *S. arizonensis*. Discriminant function analysis produces a complete separation of these two species (Hoffmeister, 1986).

GENERAL CHARACTERS. The Mexican fox squirrel (Fig. 1) is a large tree squirrel with a long, bushy tail. The upperparts are brownish suffused with reddish or ochraceous, and the underparts are reddish or ochraceous, with this color extending onto the legs and feet. The midline of the top of the tail is mostly blackish, and the midline of the underside of the tail is the same color as the underparts and is bordered with a black band and then more laterally by a tan or yellowish band. The sides of the body are reddish or ochraceous (Hoffmeister, 1986). In southern populations, the upperparts are washed with white and the underparts are whitish (Hall, 1981). The auditory bullae are not greatly inflated (Fig. 2), the skull is broad at the base of the rostrum, and the braincase is high, especially in the interorbital region (Hoffmeister, 1986).

In winter pelage, *S. n. apache* has a broad band of black extending from the crown to the root of the tail; this is seasonal and disappears with the appearance of the post-breeding pelage. The sides of the head and body are yellowish gray mixed with black. The orbital ring, feet, and undersurface of the body are ochraceous. The ears are rusty drab and ochraceous around the meatus. All tail hairs



FIG. 1. An adult *Sciurus nayaritensis chiricahuae* from Cave Creek Canyon, Chiricahua Mountains, Cochise Co., Arizona. Photograph by G. Bailey.



FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of *Sciurus n. nayaritensis* from Sierra de Cuale, 2,190 m elev., Jalisco, Mexico (female, University of Kansas Museum of Natural History 92980). Greatest length of cranium is 65.8 mm.

are ochraceous at the base. Those of the mid-ventral area of the tail are ochraceous throughout; mid-dorsal tail hairs are ochraceous at the extreme base and then black almost to the extremity, which is yellowish white. Lateral tail hairs are ochraceous at the base, pale yellowish at the end, and black in the middle; the three bands being of about equal width. The summer or post-breeding pelage is different from the winter pelage in that there is no black dorsal area. When this coat is new, the black central area of the upperside of the tail is obscured by the ochraceous tips of the hairs, and the pelage of the upper surface of the body, although with much black on the hairs, is sufficiently annulated with fulvous and hoary to produce a grizzled effect (Mearns, 1907).

Sciurus n. chiricahuae is vividly colored, with tawny thighs

and forearms contrasting sharply with the grizzled back. In summer pelage, the general dorsal area from the top of the head to the rump is a nearly uniform mixture of pale ochraceous-buff and black, producing a grizzled effect that extends well down to a sharp line of demarcation on the lower part of the sides. The limbs and underparts are pale tawny, contrasting sharply with the grizzled body color. The orbital rings, postauricular patches, tip of the nose, and lips are pale tawny like the underparts. Dorsally, the tail is ochraceous buff mixed with black. The tricolored hairs are ochraceous buff at the base, black on the median one-third, and pale ochraceous-buff toward the tips. Ventrally, the tail is pale tawny along the broad median line, interrupted by a black zone giving way to broad pale ochraceous-buffy marginal areas. In some individuals, the outer sides of the thighs are deeper tawny than in others (Goldman, 1933).

Dorsally, in *S. n. nayaritensis*, the surface of the pelage is gray, and the hairs are tipped broadly with white and subterminally ringed broadly with black. Ventrally, the surface hairs are pale rusty brown nearly to the base, this color forming a broad band occupying one-half to two-thirds the length of the hairs, which at the extreme base are rather pale and somewhat yellowish. The underfur also is yellowish. The hairs of the venter, as well as the inner surface of both fore and hind limbs, are white to the base. The color of the dorsal surface extends low on the sides of the body, and contrasts sharply with the white of the ventral surface. The outer surfaces of the forelimbs are much paler than the back, the white tips of the hairs are longer, and on the lower arm and manus the general color is whitish with less black below the surface. The outer surfaces of the hind limbs are similar, but the toes are nearly white and the dark color below the surface is more apparent on the top of the hind feet. The top of the head is darker than the back, with less fulvous beneath the surface. The eye ring and sides of the nose are white, grayish white, or yellowish white. The ears are broad, high, rounded at the top, nearly naked internally, sparsely covered with short grayish hairs externally, and with a small, poorly defined patch of soft, fulvous, or pale yellowish-white hairs at the posterior base. The tail is full and bushy, and the hairs are long. Dorsally, the tail is mixed black and white and the sides, both above and below, are broadly fringed with white. Ventrally, the tail is cinnamon rufous centrally, varying somewhat in intensity among individuals. Hairs on the underside of the tail are broadly white at the tip, rufous at the base, and have a broad intervening band of black (Allen, 1889).

In Arizona, females average slightly larger in all external and cranial measurements, except length of hind foot and postorbital constriction (Hoffmeister, 1986). Averages and ranges of external and cranial measurements (in mm) of *S. n. apache* ($n = 39$), *S. n. chiricahuae* ($n = 14$), and *S. n. nayaritensis* ($n = 41$), respectively, are: length of head and body, 282 (258–309), 283 (267–301), 287 (264–315); length of tail, 275 (259–298), 264 (250–281), 270 (237–294); length of hind foot, 78 (73–82), 75 (71–80), 77 (70–84); basilar length of cranium, 50.0 (48.5–52.5), 48.6 (47.5–50.6), 50.3 (48.0–52.7); zygomatic breadth, 37.5 (35.1–39.9), 37.9 (37.2–38.7), 37.5 (35.7–39.1); postorbital breadth, 20.5 (19.4–21.6), 21.2 (20.5–21.9), 20.3 (19.2–21.7); nasal length, 21.8 (20.1–23.7), 21.1 (20.0–21.9), 21.9 (20.4–23.7); palatal length, 28.0 (26.7–29.2), 27.5 (26.8–28.3), 28.1 (26.3–30.4); length of alveolar toothrow, 12.0 (11.2–12.5), 11.8 (11.3–12.2), 12.1 (11.5–13.0—Lee and Hoffmeister, 1963). In Arizona, mass averages 697 g (Brown, 1984). In Chihuahua, mass of one Mexican fox squirrel was 814 g (Anderson, 1972). In Durango, mass of a nonpregnant adult female was 707 g; mass of two adult males was 628 and 739 g (Baker and Greer, 1962).

Sciurus n. chiricahuae differs from *S. n. apache* primarily in the darkness of the ochraceous underparts, orbital ring, and postauricular areas. *S. n. chiricahuae* differs most strikingly from *S. n. nayaritensis* in color, both dorsally and ventrally. *S. n. chiricahuae* also has a relatively short, broad skull, short but broad rostrum, laterally expanded distal ends of the nasals, dark-ochraceous underparts, ochraceous orbital rings, and ochraceous postauricular areas (Hoffmeister, 1986).

DISTRIBUTION. The Mexican fox squirrel inhabits the mixed pine-oak forests of the upper Sonoran and transition life zones in the Chiricahua Mountains, Arizona, and the Sierra Madre Occidental, Mexico, southward as far as southern Jalisco (Fig. 3; Goldman, 1951; Hall, 1981; Lee and Hoffmeister, 1963; Monson, 1972; Nelson, 1899). In the Chiricahua Mountains, it occurs at 1,560–2,700 m elev. (Goldman, 1933), but usually is found at ca. 1,650–

1,950 m elev. (Hoffmeister, 1986). In the San Luis Mountains, Chihuahua, *S. nayaritensis* occurs at 1,700–2,100 m elev. (Mearns, 1907). *S. n. nayaritensis* occurs within the Trans-Mexican neovolcanic belt (Fa and Morales, 1991).

FOSSIL RECORD. The genus *Sciurus* evolved by the early Miocene (Black, 1972). No fossils of *S. nayaritensis* are known.

FORM AND FUNCTION. The dental formula is $i\ 1/1, c\ 0/0, p\ 1/1, m\ 3/3$, total 20 (Hall, 1981). A two-thirds grown *S. nayaritensis* had the permanent premolar just replacing its predecessor (Mearns, 1907). The hyoid apparatus consists of a single basihyal and paired thyrohyals, ceratohyals, and stylohyals; the basihyal is thick, triangular in cross-section, long, and fuses with the short thyrohyals at an early age (Hoffmeister and Hoffmeister, 1991).

The tail is bushy, the ears are thinly haired, the pelage is thick and soft, and the underfur is long (Nelson, 1899). The average ratio of length of vibrissae to width of head is 1.770 (Ahl, 1987). The naked soles of the feet are dark purplish. The iris is dark brown (Mearns, 1907). The four pair of mammae are arranged as follows: one pectoral; two abdominal; one inguinal (Nelson, 1899).

Sciurus nayaritensis is much darker in October and November than in May. In October and November, the fulvous of the underparts is deeper, and the tail is fringed with deep fulvous instead of pale fulvous or yellowish white, as in late-May individuals from the same area (Allen, 1904). On 11–13 July, three adult males from the San Luis Mountains were in worn winter pelage, but this was being replaced on both upper and lower surfaces by the pepper-and-salt summer coat. On 11 July, an adult female had almost completely changed to summer pelage, except on the thighs and tail. On 31 August, an adult female had completed the post-breeding coat. On 7 September, an immature female was in complete summer pelage (Mearns, 1907).

ONTOGENY AND REPRODUCTION. In the San Luis Mountains, one female contained three embryos on 11 July (Mearns, 1907). In Durango on 1–2 July, females were lactating (Baker and Greer, 1962). In Chihuahua, two pregnant females were present on 19 July; one had two embryos and the other had three (10–15 mm in length—Anderson, 1972). In the Chiricahua Mountains on 16 August, one female had enlarged mammary glands and probably was still nursing (Hoffmeister, 1986); a young was observed on 13 July. In Arizona, parturition apparently occurs in April (Cahalane, 1939).

ECOLOGY. In the Chiricahua Mountains, *S. nayaritensis* inhabits the partially open Apache pine-oak (*Pinus engelmanni-Quercus*) forest, rather than living in dense stands of trees (Hoffmeister, 1986). The Mexican fox squirrel occurs in greatest abundance in the dense growth of trees and shrubs in the canyon bottoms of the upper Sonoran zone and appears to avoid the oak-covered slopes, except possibly when acorns are numerous. The lower canyons are not the exclusive range, however; one Mexican fox squirrel was seen in large oaks at 2,250 m elev., another in Douglas firs (*Pseudotsuga menziesii*) at 2,580 m elev. on 30 June and 9 July, respectively, and one on 9 July at the upper limit of oaks at 2,400 m elev. (Cahalane, 1939). *S. nayaritensis* is not numerous and there is some fluctuation in numbers from year to year. It is found primarily in riparian habitats with sycamores (*Platanus*), ashes (*Faxinus*), walnuts (*Juglans*), and large evergreen oaks. In some seasons, *S. nayaritensis* occurs to the upper limit of evergreen oaks (Monson, 1972).

In Zacatecas, *S. nayaritensis* seems most prevalent in montane forests dominated by oaks (Matson and Baker, 1986), or in the pine-oak community (Jones and Webster, 1977). The Mexican fox squirrel is common in the pine belt at high elevations in eastern Sonora almost the entire length of the state (Burt, 1938; Caire, 1978). In the Bavispe River Valley, Sonora, *S. nayaritensis* occurred in hackberry (*Celtis reticulata*), sycamore, and walnut trees. Several were observed in large pine trees and on the ground in October (Caire, 1978).

In southwestern Durango, *S. nayaritensis* is fairly common in oak-pine forests above 2,100 m elev.; most are in ponderosa pines (*Pinus ponderosa*—Baker and Greer, 1962). In western Durango, the Mexican fox squirrel also is common in the mixed forests of pines and oaks, but here it lives in hollow oaks, entering by a knot hole or broken branch and rarely is seen on the pines (Nelson, 1899).

In Arizona, nests of *S. nayaritensis* are much like those of *S.*

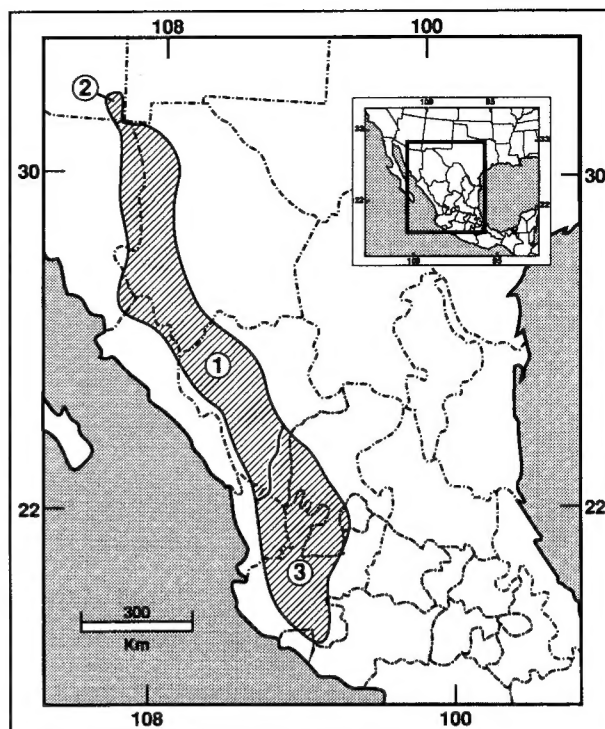


FIG. 3. Distribution of *Sciurus nayaritensis* in the southwestern United States and western Mexico (Hall, 1981): 1, *S. n. apache*; 2, *S. n. chiricahuae*; 3, *S. n. nayaritensis*.

arizonensis. In the Chiricahua Mountains, the Mexican fox squirrel nests in oaks and pines, either in leaf nests out on the branches or within hollows and holes in the trunks (Hoffmeister, 1986). In Durango, leaf nests were seen in two oak trees (Baker and Greer, 1962). In the San Luis Mountains, nests were in the oak zone at 1,700–1,800 m elev. *S. nayaritensis* eats acorns of *Quercus hypoleuca*, and most of the nests were placed in trees of this species (Mearns, 1907).

In the Chiricahua Mountains, food items of the Mexican fox squirrel are seeds of pines and Douglas fir, acorns, and walnuts (Hoffmeister, 1986). Roots, bulbs, and buds apparently supply food during the season when oak mast or other tree seed is not available. One was observed foraging on the ground and was eating a bulb about the size of an acorn (Cahalane, 1939). In the San Luis Mountains, *S. nayaritensis* eats acorns of *Quercus hypoleuca* (Mearns, 1907). In southwestern Durango, piles of dismembered cones at the bases of ponderosa pine trees indicated *S. nayaritensis* was eating pine seeds (Baker and Greer, 1962).

Sciurus nayaritensis occurs sympatrically with *S. aberti* in the Sierra Madre Occidental. The upper limit of the range of *S. nayaritensis* overlaps the lower limit of *S. aberti*, but neither occupies much territory of the other (Nelson, 1899). In Chihuahua, *S. nayaritensis* occurs with *S. aberti* over most of its range, but is less abundant than *S. aberti* at higher elevations in pine forests. *S. nayaritensis* also occurs at lower elevations than *S. aberti*, beyond the limits of the range of *S. aberti*, and in oak forests below the zone of pines inhabited by *S. aberti* (Anderson, 1972). Where sympatric in Durango, *S. aberti* is more common, but near Pueblo Nuevo, only *S. nayaritensis* is found. Elevationally, this is just above the subtropical vegetation, which grows in deep canyons. One *S. nayaritensis* was observed here on a steep hillside of open woodlands of mixed ponderosa pine and a broadleafed oak (*Quercus macrophylla*—Baker and Greer, 1962).

Sciurus nayaritensis may be sympatric with *S. aureogaster* in southwestern Mexico (Musser, 1968). In Zacatecas, *S. nayaritensis* occurred sympatrically with *S. aureogaster* 16 km NW Yahualica (Matson and Baker, 1986).

Sciurus colliiei is sympatric with *S. nayaritensis* in Jalisco on the Sierra de Cuale (*S. colliiei* occurred in a canyon in subtropical broadleaf vegetation and *S. nayaritensis* on the slopes in pine), and

they have been observed together in Sinaloa. They probably are sympatric elsewhere along the western margins of the Sierra Madre Occidental northward to Chihuahua (Musser, 1968). *S. nayaritensis* usually lives at higher elevations than *S. colliaei* (Anderson, 1962; Caire, 1978; Hall, 1981).

Based on data from Zacatecas, numerical analyses placed *S. nayaritensis* with other species that occur in montane habitats (Matson, 1982). In Durango, *S. nayaritensis* occurred with *Didelphis marsupialis*, *Myotis velifer*, *Eptesicus fuscus*, *Lepus callotis*, *Sylvilagus floridanus*, *Spermophilus variegatus*, *Tamias bulleri*, *Thomomys umbrinus*, *Reithrodontomys megalotis*, *Peromyscus boylii*, *P. difficilis*, *P. truei*, *Sigmodon leucotis*, *Neotoma mexicana*, *Nelsonia neotomodon*, *Canis latrans*, *C. lupus*, *Urocyon cinereoargenteus*, *Ursus americanus*, *Procyon lotor*, *Mephitis macroura*, *Conepatus mesoleucus*, *Felis concolor*, *Lynx rufus*, and *Odocoileus virginianus* (Drake, 1958).

Ectoparasites include the lice *Neohaematopinus sciurinus*, *Enderleinellus longiceps* (Ferris, 1951), *E. arizonensis*, and *E. nayaritensis* (Kim, 1966), and the flea *Opisodasys robustus* (Traub et al., 1983). No endoparasites are known.

In the Chiricahua Mountains, *S. n. chiricahuae* largely is restricted to the recreational area of the mountains, which attracts a great number of people; it is conspicuous, and even after considerable association with humans it has not learned wariness. Although legally protected, the Mexican fox squirrel once suffered from the depredations of irresponsible humans (Cahalane, 1939). *S. n. chiricahuae* has been listed as a category-two species by the United States Department of the Interior, Fish and Wildlife Service. This category includes taxa that are candidates for listing as endangered or threatened, but which lack conclusive data (Drewry, 1991). In Mexico, *S. nayaritensis* has suffered habitat loss through logging, burning, and the clearing of forests for agriculture (Leopold, 1959; Nowak, 1991).

BEHAVIOR. The Mexican fox squirrel is a forager, does not cache food, and does not regularly bury nuts. Depending upon its feeding habits and time of year, *S. nayaritensis* may be secretive or readily observed. It may be especially difficult to locate during early summer, when females are pregnant and nursing young. The Mexican fox squirrel also can be shy and hard to find in winter, when forests are bare and open (Brown, 1984). *S. n. chiricahuae* usually avoids occupied picnic and camping areas and does not visit feeding stations or garbage cans; it is only attracted to native foods (Hobbs, 1980).

In the Chiricahua Mountains, *S. nayaritensis* frequently is seen on the ground. For example, five were observed in a small area on a cold 3 January. Most of these were on the ground under or near oaks. In summer, animals were not as closely spaced, nor were they so close to the road. The behavior of *S. nayaritensis* on the ground is much like that of *S. niger* (Hoffmeister, 1986).

In the Chiricahua Mountains, one young-of-the-year was active 22 August. It almost lost its hold on the trunk of a large ponderosa pine. This clumsiness in climbing also is a noticeable characteristic of adults. They often slip and slide on tree trunks or branches (Cahalane, 1939).

When danger is perceived, the usual defense of *S. nayaritensis* is to remain motionless. This prolonged immobility may occur even when the squirrel is in clear view of humans. When feeding high up in trees (≥ 18 m above the ground), this behavior is an effective defense. When caught out in the open or startled, the Mexican fox squirrel retreats to the tallest trees and disappears behind a large bough or into a den cavity. Frightened animals may remain hidden and motionless for ≥ 45 min (Brown, 1984).

Usually the Mexican fox squirrel is silent, except for chucking and barking alarm calls. When it is vocalizing, *S. nayaritensis* invariably is in a tree. Alarm barks vary among individuals, but generally are more raspy and gruff than the quirk calls of *S. aberti*, and may be followed by a whirring screech or scream (Brown, 1984; Hobbs, 1980). *S. n. apache* is more vocal than the usually silent *S. n. chiricahuae*. In encounters with other species, *S. n. chiricahuae* faces toward the disturbance and usually makes the tail-flicking movements commonly associated with alarm calls, but does not vocalize. Even dives by Cooper's hawks (*Accipiter cooperi*) failed to elicit alarm calls from *S. n. chiricahuae*, but screaming sounds were made by *S. n. apache* in response to humans and to a hawk (Hobbs, 1980). Nothing is known concerning the genetics of *S. nayaritensis*.

REMARKS. *Sciurus nayaritensis* is closely allied with *S. niger* (Lee and Hoffmeister, 1963), and *S. nayaritensis* and *S. arizonensis* may be subspecies of *S. niger* (Brown, 1984; Hall, 1981; Lee and Hoffmeister, 1963). Squirrels ancestral to *S. nayaritensis*, *S. oculatus*, and *S. alleni* may have spread from western Mexico across the Mesa del Norte by way of mountains in western Coahuila, Durango, and Zacatecas (Baker, 1956).

Sciurus is from the Latin meaning squirrel (Jaeger, 1955). The type of *S. alstoni* came from the Sierra de Valparaiso, Zacatecas, but in renaming *S. alstoni* J. A. Allen called it *S. nayaritensis* for the Nayarit Mountains, a part of the Sierra Madre Occidental ca. 160 km southwest of the type locality (Nelson, 1899). I have followed Hoffmeister (1986) and Jones et al. (1992) in using Mexican fox squirrel as the common name of *S. nayaritensis*. *S. nayaritensis* also has been referred to as the Nayarit, Apache (Nelson, 1899), Chiricahua Mountain (Goldman, 1933), Apache fox (Monson, 1972), and Chiricahua Nayarit squirrel (Drewry, 1991).

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